DOCUMENT RESUME

ED 466 167 IR 021 238

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TITLE	Teaching, Learning and Computing: What Teachers Say.
PUB DATE	2001-06-00
NOTE	7p.; In: ED-MEDIA 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications. Proceedings (13th, Tampere, Finland, June 25-30, 2001); see IR 021 194.
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Computer Attitudes; *Computer Uses in Education; *Constructivism (Learning); *Educational Development; Educational Practices; Educational Technology; Elementary Secondary Education; Learning Activities; Professional Development; Teacher Attitudes; *Teaching Methods; *Technology Integration
IDENTIFIERS	*Technology Role

ABSTRACT

This paper examines the results from the "Teaching, Learning and Computing (TLC)" survey (Becker, H.J. & Anderson, R.E., 1998) administered to the "Applying Technology to Restructuring and Learning" (ATRL) project participants. The ATRL project was a five-year project funded by the U.S. Department of Education, Office of Educational Research and Improvement, and carried out by the Southwest Educational Developmental Laboratory's Technology Assistance Program. The primary purposes of the project were to document how teachers and their teaching practices changed as they integrated technology in their classrooms and to document the role that technology played in that process. A major activity of this project was the design, development, and delivery of 72 hours of professional development that modeled constructivist learning environments supported by technology. The TLC results were examined to shed light on the benefits of the ATRL professional development intervention and also to help inform the three research questions under consideration in this study: (1) What do constructivist learning environments supported by technology look like in practice? (2) How can teachers be assisted in developing constructivist learning environments supported by technology? (3) How does technology facilitate the development of a constructivist learning environment?(Author/AEF)

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Teaching, Learning and Computing: What Teachers Say

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IR021238

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Abstract: This paper examines the results from the *Teaching, Learning and Computing (TLC)* survey (Becker, H.J. & Anderson, R.E, 1998) administered to the *Applying Technology to Restructuring and Learning* (ATRL) project participants. The TLC results were examined to shed light on the benefits of the ATRL professional development intervention and also to help inform the three research questions under consideration in this study: (1) What do constructivist learning environments supported by technology look like in practice? (2) How can teachers be assisted in developing constructivist learning environments supported by technology? (3) How does technology facilitate the development of a constructivist learning environment? A copy of the full research report can be obtained from mheath@sedl.org

Background of the study

The *Applying Technology to Restructuring and Learning (ATRL)* project was a five-year project funded by the US Department of Education, Office of Educational Research and Improvement and carried out by the Southwest Educational Development Laboratory's Technology Assistance Program. The primary purposes of the project were to document how teachers and their teaching practices changed as they integrated technology into their classrooms and to document the role that technology played in that process. A major activity of this project was the design, development, and delivery of 72 hours of professional development that modeled constructivist learning environments supported by technology.

Six schools from across the five states of the Southwest Educational Development Laboratory region were selected to participate in this study. Site selection was based upon the following criteria: (1) High concentrations of economically disadvantaged populations based on the percentage of students qualifying for free and reduced lunch. (2) High concentrations of culturally and linguistically diverse students. (3) Rural and urban settings in the U.S./Mexico border region, Mississippi Delta region, and the Indian nations. (4) A commitment from administrators and 25 classroom teachers to support the creation of technology-rich learning environments that employed instructional approaches consistent with constructivist learning theory. Teachers either volunteered for participation or were recommended by their principals were some of several criteria were used for selecting the site schools.

Three broad questions guided the research study and created a framework for investigation and analysis: (1) What do constructivist learning environments look like in practice, particularly in classrooms with high populations of culturally and linguistically diverse students? *Will a single model emerge?* (2) How can teachers be assisted in developing constructivist learning environments supported by technology? *What school context issues or teacher qualities influence this development and what role does professional development play in bringing about this development?* (3) How does technology facilitate the development of a constructivist learning environment? *How do teachers use technology and how does technology allow or promote a change in the way they teach?*

The research component of the ATRL project was a *two-tiered design. Tier one* was a collective case study of the approximately 150 classrooms whose teachers participated in two years of the study and who attended 72 hours of professional development sessions developed and delivered by the ATRL project staff. The unit of study in tier one was the classroom. Data were collected for each of the 150 teachers in this study, including demographic data, classroom observations (using a highly structured observation protocol), sample lesson plans, teacher personal profiles, teacher self-assessments of computer skills, responses to professional development sessions, informal interviews, e-mail correspondence, and field notes. Analysis of this data helped inform how teachers changed their teaching practice and the role that technology played in that process. *Tier two* was a collection of six exemplary case studies selected from the 150 project teachers and whose practice exemplified learner-centered classrooms. Each teacher selected represented a different style and approach to both teaching and integrating technology as well as representing different stages of the change process that they have individually experienced across the two years of the project. An exploration of their experience, beliefs, practices, and thoughts during the process provides a "rich description" for understanding the process of creating constructivist learning environments supported by technology. Discussion of the case studies can be found in another paper: *Creating Constructivist Learning Environments Supported by Technology: Six Case Studies* included in the Ed-Media 2001 proceedings.

The *Teaching, Learning, and Computing* (TLC) survey (Becker, H.J. & Anderson, R.E, 1998) was one of the instruments used in *tier one* of the study. The TLC survey asked teachers to describe their best practices, teaching philosophies and uses of technology. The purpose of the survey was to compare ATRL project participants to a national sample of teachers and computer-using teachers. The TLC results were examined to shed light on the benefits of the ATRL professional development intervention and also to help inform the three research questions under consideration in this study.

In an earlier report, ATRL teachers were compared to a TLC national probability sample that contained 2251 teachers from all subjects (grades 4 - 12), 60% who were computer users in the class in which they felt they most often accomplished their teaching objectives (Becker, Ravitz, & Wong, 1999). In this earlier comparison, ATRL project teachers reported having access to technology at a higher rate than the national sample: computers in their classrooms (81.7% vs. 62.2%, access to a printer (98.1% vs. 77.8%), access to high speed internet from classroom (71.2% vs. 25.6%) and access to e-mail (97.1% vs. 51.9%).

For more accurate comparison purposes for this report, 104 TLC teachers were selected from the large national sample who taught in middle and elementary schools, in rural and town settings, and with low income and minority populations and who taught in those same states as the ATRL teachers. In future analyses we will also compare teachers who have received similar amounts of professional development but for this report we focus on teachers, who work in similar settings, not who received similar treatments. The ATRL group contained 102 teachers, 90% who were computer users in the class in which they felt they most often accomplished their objectives, and had just completed 72 hours of professional development. The amount of professional development that TLC teachers received was not determined.

Findings

Analysis of data to help inform research question one "What do constructivist learning environments supported by technology look like in practice?" revealed that there was no single model of a constructivist learning environment supported by technology. However, these learning environments appeared to share a number of common characteristics. When compared to baseline observation data, students in these classrooms had become more active, autonomous, and appeared to be highly engaged with the subject matter or learning content. Oftentimes they worked collaboratively with peers to solve a problem, presented findings or completed a project and used technology to accomplish their tasks. In such an environment the curriculum was structured in such a way to allow students greater flexibility and authority in terms of their own learning. The teacher, while an integral part of the classroom, acted more as a producer, rather than a director, setting up the learning situation and then allowing students to use the means necessary to arrive at a certain end.

Responses to the TLC survey told us about the types of and the frequency of computer use by ATRL teachers. Our earlier report, which compared ATRL teachers to the TLC national probability sample of teachers (not controlling on the variables mentioned above) showed that a far greater proportion of ATRL teachers increased their use of computers. Compared to five years ago, twice a greater percentage of ATRL teachers than the TLC national sample reported trying new software much more now (42.2% versus 21.7%). More than twice a greater proportion of ATRL teachers than the TLC teachers were using email 3-4 times a week (56.9% versus

24.7%). ATRL teachers were using computers more to much more for class preparation than the TLC teachers (90.1% versus 71.6%) and were also using computers for non-work activities more to much more (88% versus 69%).

Not only did ATRL teachers appear to report increased computer use; their objectives for use appear to be more consistent with a constructivist view of instruction. Using the smaller "comparison" sample from the study, Table 1 compares ATRL teachers to the comparison sample from the TLC study, using the controls, in their objectives for using computers with students. Percents are for teachers who said they used computers in the class in which they felt they most often accomplished their teaching objectives. As the data illustrate, ATRL project teachers listed the more constructivist objectives as being among the TOP 3 more often than the comparison group. Presenting information, working collaboratively, and communicating electronically were rated among the more constructivist objectives by the TLC's authors.

Table 1: Percent of teachers in each category reporting their Top 3 Objectives for computer use

	ATRL (104)	TLC sample (102)
Mastering skills just taught	21%	15%
Remediation of skills not learned well	15%	21%
Expressing themselves in writing	21%	18%
Communicating electronically with other people	**16%**	**2%**
Finding out about ideas and information	24%	22%
Analyzing information	18%	15%
Presenting information to an audience	**23%**	**10%**
Improving computer skills	**24%**	**12%**
Learning to work collaboratively	**36%**	**16%**
Learning to work independently	28%	23%
Other	**16%**	00%

Interestingly, while the N is low among the TLC teachers who taught in control conditions (low-income, minority, in region) when we further distinguish teachers who were identified for TLC using probability sampling, (contrasting these with the TLC teachers identified in the "purposive sample" of high technology schools and reform programs) we find that those in the purposive sample expressed considerably less constructivist compatible objectives, even compared to teachers from the TLC probability sample. This suggests those major reform and technology settings in these low-income and largely minority communities are substantially less constructivist than even the normal teaching. The evidence is that ATRL has taken a different path from other technology and reform efforts in these communities. Compared to the TLC "control" sample, that includes reform and technology use, ATRL teachers were substantially more likely to report a "top" objective of communicating electronically (16% vs. 2%), presenting information to an audience (23% vs. 10%), and learning to work collaboratively (36% vs. 16%).

To help inform research question two "How can teachers be assisted in developing constructivist learning environments supported by technology?" analysis of changes in teachers' practice indicated that changes were based in part on the professional development sessions provided for them. Since the ATRL project provided 72 hours of professional development over two academic years of the project, the expectations were that project teachers would score higher than the national sample on many of the TLC items. Site reports and classroom observations showed that teachers were able to use the learner-centered and technology management strategies that were modeled in various professional development sessions. ATRL project teachers indicated that the constructivist approaches modeled in the professional development sessions helped them understand how they could manage their classrooms using some of the same strategies. Furthermore, responses to TLC items as shown in Table 2 indicate that professional/staff development influenced their teaching practice through changes of their understanding of learning and the use of technology. Also,

responses indicate that the person who gave them the best ideas about teaching knew a lot about computers.

Table 2: Comparisons of TLC teachers and ATRL teachers on the impact of professional/staff development.

TLC Item	ATRL	TLC
Staff development/workshops have influenced their teaching practice	77.4%	52.2%
A change in their understanding of learning has influenced their teaching practice	73.8%	69.6%
Computer/technology opportunity and experience has influenced their teaching practice	78.7%	50.7%
The person who gives them the best ideas about teaching knows a lot about computers	50%	37%

Results of the TLC analysis also helped to inform research question three "How does technology facilitate the development of a constructivist learning environment?" ATRL teachers indicated that they used computers in the class where they felt more successful. They also indicated that they allow students interest influence the choice of lesson topics and that computers play a substantial-major role to changes to students assignments.

Fifty seven percent of ATRL project teachers reported that computers played a substantial or major role in changing their teaching on the TLC survey, as compared with only twenty-eight percent of the comparison sample. Table 3 reports the comparison of ATRL teachers to the comparison sample in the various ways in which computers changed teaching practice: organization of space, organization of class activities, curriculum priorities, and teaching goals.

Table 3: Comparisons of TLC teachers and ATRL teachers on how technology has changed teaching practices.

TLC Item	ATRL (104)	TLC (102)
I use computers in the class where I feel most successful	90.2%	60.1%
Compared to 3 years ago, I let student interest influence lesson topics	Much More now 31.4%	Much more now 15%
How much of a role have computers played in changes to student assignments?	Substantial-Major Role 60.7%	Substantial-Major Role 30.8%
How much of a role have computers played in changes in your teaching practice	Substantial-Major role 57.3%	Substantial-Major role 27.5%
Computers affect the way you organize space in your classroom	Big change 30.4%	Big change 17.10%
Computers affect the way you break up your class period into activities	Moderate-Big change 61.4%	Moderate-Big change 31.8%
Computers affect your beliefs about curriculum priorities	Moderate-Big change 54.9%	Moderate-Big change 37.5%
Computers affect your goals in teaching	Moderate-Big change 54.9%	Moderate-Big change 45.4%

Discussion

Most ATRL teachers had little or no experience using technology with constructivist practices in their classroom prior to the ATRL professional development intervention. While many of the participant teachers initially expected technology-skills training in the professional development sessions, they instead received a

much richer technology curriculum-integration learning experience with meaningful authentic learning experiences and greater learner control. One of the goals for the professional development was to create activities that used limited numbers of computers rather than having a computer available for every person. The logic was that if teachers had to teach with a limited number of computers, it would be more meaningful for them to participate in sessions with limited computers. The object was to help teachers learn how to manage limited resources instead of becoming an "expert" in any single computer application. Each of the staff development sessions was supported by constructivist learning theory and took into account teachers' understanding and beliefs about how students learn. Each session utilized inquiry, problem-based teaching and learning along with commonly available software found in classroom settings. Sessions also modeled instructional strategies or classroom management strategies that supported technology assisted constructivist learning environments.

Changes occurred as teachers became increasingly confident and comfortable using technology. There appeared to be a link between teachers' comfort or confidence with technology and their use of technology with students. The computer skills self-assessment and the TLC survey indicated that participating teachers increased their use of technology with students. In baseline reporting, only 50 percent of teachers reported using the computer with students on a regular basis. By the end of year two, 75 percent reported regular computer use with students. Technology, when used with students, seemed to play a role in the creation of constructivist learning environments. Analysis of the computer skills self-assessment data, the TLC survey, field notes, teacher interviews, and informal observations indicated that when technology was used, it helped teachers shift practices toward more constructivist approaches. Indeed, such an observation is consistent with other research linking technology use and pedagogical practices (For example, Jonassen, Carr, and Hsui-Ping, 1998).

In general, observations also showed that successful technology integration and high technology use took place in those classrooms where there were four to six computers available for student use. On the other hand, the presence of four to six computers in a classroom was not a guarantee that technology use or constructivist practices took place. For example, one teacher found that six computers were too many to manage. She explained that it totally "disrupted" her classroom organization with students working on too many activities. She also found it difficult to handle technology issues while trying to carry out instruction. In her case, technology was forcing her to change her teaching practice in a way that was unexpected and undesirable. However, another teacher who had ten computers had previously been a computer teacher in a lab setting. He could successfully manage several computers and enjoyed having students working on multiple activities.

As they learned to use technology, teachers became conscious of themselves as learners, of what technology could offer them, and became more cognizant of best instructional practices using technology. Furthermore, as teachers became more comfortable with technology, they were more likely to let students use it. Once teachers allowed students to use technology and saw that many students had a certain amount of expertise they were more likely to cede control of technology to students. Once this control was loosened and teachers saw that students worked well with technology and that their work improved as a result, they began to loosen control in other areas, granting students' greater autonomy in their work. This process was a gradual one but resulted in the locus of activity shifting from the teacher to the student. The teacher became less a repository of knowledge and more a general manager of classroom operations. The student role, in turn, was also transformed from a spectator to the protagonist in the learning process.

Summary

Technology adds yet another skill set that teachers must master. As Sandholtz et al. (1997) point out, "The addition of technology can exacerbate or enhance the already complex challenge of teaching" (p. 183). While the addition of technology did complicate many of the ATRL teachers' lives, professional development activities that modeled ways to integrate technology helped teachers learn both new instructional strategies while learning and using technology. Supporting research (Brand

1998; Education Week, 1999) shows that technology curriculum-integration rather than technology skills training should be the primary focus of technology-centered staff development. A national survey of teacher's use of digital content (Education Week, 1999) reveals that sixty five percent of teachers who received eleven hours or more of technology integration training say they feel "much better" prepared to use technology than they did twelve months ago. Unfortunately, in practice, only twenty nine percent of teachers receive six or more hours of curriculum-integration training.

Conclusions indicate that professional development for in-service teachers must be a top priority, especially professional development that emphasizes the effective integration of technology into the curriculum. The ATRL professional development intervention helped serve that need by providing a total of 72 hours of technology integration training over a two-year period. Instruction in those professional development sessions focused on and illustrated how technology supports educational objectives via instructional environments such as collaborative problem solving and cooperative learning activities. And most importantly, activities were designed that engaged teachers both intellectually and professionally.

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